COMPREHENSIVE DICTIONARY OF PHYSICAL CHEMISTRY

Editors

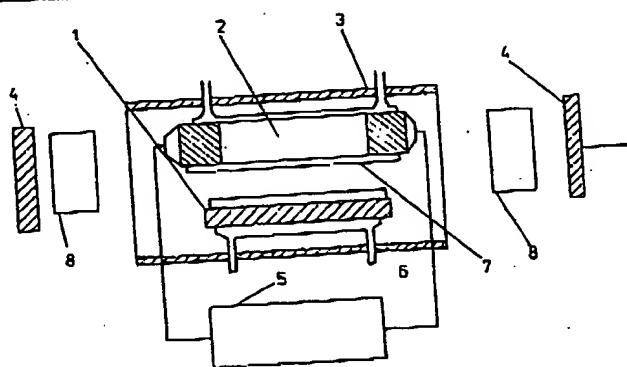L. ULICKÝ Dipl. Ing., Ph.D.
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solubility

Solid-state laser

1 — active medium, 2 — pumping source, 3 — reflector, 4 — resonator mirrors, 5 — energy supply, 6 — cooling system, 7 — radiation, 8 — active elements

As examples of solid-state lasers can be mentioned the *ruby laser* with synthetic corundum (aluminium oxide with Al^{3+} ions replaced by Cr^{3+}) as the active medium and with $\lambda = 694$ nm; the *neodymium laser* with a synthetic crystal of yttrium-aluminium garnet (NdYAG) as the active medium, where a part of the Y^{3+} ions is replaced by Nd^{3+} ions, and with $\lambda = 1.06$ μm; the *semiconductor laser*, whose laser action occurs in a semiconductor, etc. Lasers with these active materials operate on the principle of optical ⁄ pumping (*Fig.*). The population inversion is achieved by the absorption of a light flash from a discharge lamp (usually xenon) with pulsed or continuous regime and with the discharge spectrum coinciding with the absorption spectrum of the activators. The efficiency of laser action depends on the ability of the active material to absorb the pumping energy in a specified region of the spectrum. The more the energy is absorbed, the higher is the efficiency of the active medium and the more radiant energy can be obtained from the laser.

The emission spectrum of xenon lamps exhibits a considerable dependence on the energy emitted during a pulse. This energy depends on the temperature of the discharge plasma and the higher is the energy in one pulse, the larger is the fraction falling in the short-wave region. To produce a suitable energy distribution though out the active medium, a special reflector is constructed. It consists of circular or elliptical cylinders in which the active medium and the lamp are placed in parallel. Two basic parameters characterize the reflector: the efficiency is defined as the ratio of the light flux incident on the surface of the active medium to the total light flux radiated from the lamp; the uniformity coefficient is defined as the ratio of the mean value (over the cross section of the active medium) of the pumping energy density to its maximum value.

The atoms of the activator pass into their upper energy levels due to absorption of the pumping energy. At a certain moment, the population of the upper level begins to exceed that of the lower one, i.e. population inversion occurs in the medium and the hitherto absorbing quantum level becomes an amplifying level. The laser effect in the active medium is supported by a feedback, the role of which is played by the ⁄ optical resonator.

Valko

solubility — the ability of a substance to form a solution with a solvent; when the solubility is limited it is expressed by the composition of the corresponding saturated solution (⁄ saturated solution).

Two substances can often be mixed in an arbitrary ratio — their mutual solubility is unlimited. When the solubility is limited, the composition of the corresponding saturated solution is expressed by an intensive quantity, e.g. by the mole fraction, mass fraction or by the concentration of the amount of substance, etc.
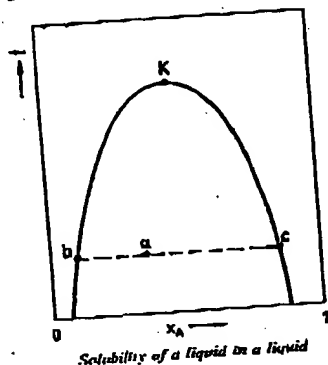
The solubility of a gas in a liquid (⁄ absorption coefficient of a gas) is a function of temperature and pressure, whereas the solubility of a solid substance in a liquid depends significantly only on temperature, its dependence on pressure being usually negligible (⁄ Schroeder's equation). The

mutual solubility (miscibility) of two liquids with limited solubility, which form ↗conjugate solutions (↗solubility of a liquid in a liquid), is significantly dependent on temperature. The dependence of the solubility of a substance in a solvent is mostly displayed graphically using a phase diagram (↗solubility of a solid substance in a liquid). *Lis*ý

solubility of a liquid in a liquid — the ability of a liquid to form, at a given temperature and pressure, a solution with another liquid (↗solubility).

Two liquids, whose solutions are characterized by a large positive deviation from ↗Raoult's law, form two phases if they are mixed in certain proportions. When adding one of the two liquids to the other one, the limit of solubility is reached and eventually exceeded; then two phases appear in the system. Usually, but not always, the mutual solubility of the two components increases with increasing temperature.

critical point K, it is unlimited. At a temperature higher than this so-called critical solution temperature, the liquids A and B form a single liquid phase in any ratio.

In some systems the mutual solubility of the components increases when temperature is lowered; these systems are characterized by a low critical solution temperature. Other systems (e.g. water — nicotine) are distinguished by both upper and lower solution temperatures.

The mutual insolubility of two substances in the liquid state is used in steam distillation. *Lis*ý

solubility of a solid substance in a liquid — the ability of a solid substance to form, at a given temperature and pressure, a solution with a liquid; it is expressed by the composition of the corresponding ↗saturated solution.

The properties of a two-component system,

Solubility of a liquid in a liquid

The curve on the graph of the dependence of the mutual solubility of liquids A and B (*Fig.*) defines the region of separation. When the state of a substance is determined by a point in this region, the system is composed of two phases. For instance, a system whose state is determined by point a consists of two equilibrium (saturated) phases with compositions determined by points b and c. These are so-called conjugate (coupled) solutions (↗conjugate solution). Point b determines the solubility of liquid A in liquid B and point c the solubility of liquid B in liquid A at the corresponding temperature. The straight line connecting points b and c is called a *tie-line*. When the temperature increases, the mutual solubility of liquids A and B also increases and, at a temperature higher than that corresponding to the
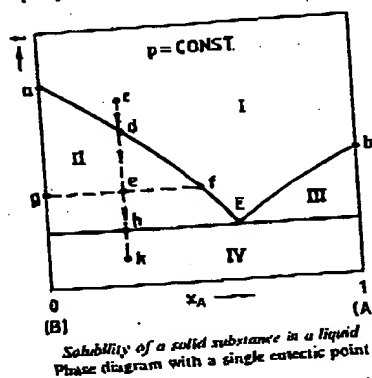

Solubility of a solid substance in a liquid
Phase diagram with a single eutectic point

whose components can be mixed in the liquid state and do not mix in the solid state (they do not form solid solutions), can be displayed in a phase diagram. An isobaric phase diagram of components A and B (*Fig.*) expresses the relation between the temperature of the system and its composition given by the mole fraction x_A (x_B) of the component A (B). A system whose state is given by a point in the region I is a one-component system, it is a liquid solution (or molten mixture) of components A and B. By cooling the solution whose state is given by point c to the temperature corresponding to point d, the saturated solution begins to solidify and the pure solid substance B is eliminated from it. The system whose state is given by point e (a point in the region II) is a two-phase system, composed of the